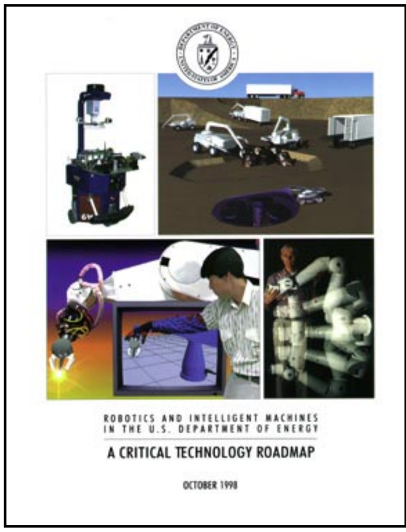

A DOE SUCCESS: The RIM Roadmap

The Project: In March 1998 representatives of nine Department of Energy (DOE) Offices (Defense Programs, Environmental Management, Science, Energy Efficiency and Renewable Energy, Environmental Safety and Health, Fossil Energy, Nuclear Energy Science and Technology, Nuclear Non-proliferation and Materials Disposition) met with DOE laboratory scientists and engineers to begin a six-month process to define, for the first time, a DOE-wide vision for the evolution, from basic research to application, of robotics and intelligent machines (RIM) technology. The result, *Robotics and Intelligent Machines in the U.S. Department of Energy: A Critical Technology Roadmap*[1], was published in October 1998. This strategic technology roadmap traced the connection between DOE's multiple mission needs e.g., the need to remediate contaminated sites and maintain the nuclear stockpile in a safe, secure, and more cost-effective manner and the future of robotics science and technology (S&T) from today through the year 2020. The *Roadmap* described in detail how advances in robotics and intelligent machines would dramatically improve DOE's manufacturing, hazardous and remote operations, and monitoring and surveillance activities.

Development of the *Roadmap* began with a discussion of DOE's major mission needs in the 2004, 2012, and 2020 timeframes. From this, the Roadmapping Team was able to identify areas and timeframes—functional objectives—in which advances in RIM technology could accelerate each DOE office's ability to meet its goals. After identifying a set of functional objectives, the Roadmapping Team determined the underlying basis technology areas of RIM (perception, reasoning, action/motion, and integration), and the individual applications relevant to each functional objective—thus mapping the pathway a technology will follow for incorporation into each DOE office's operations

The *Roadmap* provided, for the first time, a framework through which one could view how R&D across RIM's four basis technology areas will contribute to the accelerated development and deployment of robotic systems to meet DOE's needs in an integrated way. The identification of functional objectives and their associated timeframes now serve as guideposts for end-users and the R&D community to identify and/or anticipate technological needs and capabilities over the next twenty years.

The Impact: The process of developing the *RIM Roadmap* is already yielding benefits to the DOE and its laboratories. Needs-based decisions about R&D priorities and research direction are now made by participating DOE Offices in the context of an emerging cross-Department understanding of the future of RIM technology, grounded in the context of DOE's needs, and understood by the supporting institutions. The RIM Initiative is consolidating these gains into a stronger program that will broaden the application of RIM throughout DOE and, in so doing, accelerate DOE's ability to remove workers from hazardous environments; decrease manufacturing, decontamination, and decommissioning costs; and improve other operational efficiencies.

[1] The document. *Robotics and Intelligent Machines in the U.S. Department of Energy: A Critical Technology Roadmap,* available from the Intelligent Systems and Robotics Center at Sandia National Laboratories and located on the Internet at www.sandia.gov/isrc.

Future Advances through the RIM Initiative:
The functional objectives described in the *Roadmap* for the year 2004 are summarized in the table below:

PRINCIPAL SECRETARIAL OFFICE	FUNCTIONAL OBJECTIVES
Defense Programs	• Time and cost for refurbishment of appropriate stockpile hardware reduced by 50% • Worker exposure to hazards to 30% of current • Production defects reduced by 90%
Fissile Materials Disposition	• 75% reduction in exposure • 50% increase in operational throughput • 75% reduction in monitoring cost *These are examples. There are goals specific to different MD facilities.*
Nuclear Energy, Science and Technology	• Enable extreme environment operations/reduce risk at Chornobyl • Improve DOE reactor and commercial reactor operation • Reduce exposure (75%) and costs (50%) associated with maintenance of depleted UF_6 cylinders in storage
Nonproliferation and National Security	• Improve surveillance, accountability, and protection of domestic and international weapons-grade nuclear material
Environmental Management	• Personnel exposure reduced by 90% • Secondary waste reduced by 75% • Productivity increased by 300%
Science	• Inherently distributed missions in dynamic, uncertain environments • Sensor integration for distributed robot systems • Revolutionary collaborative research using remote and virtual systems • Intelligent machines concepts and controls methodologies for manipulative tasks • Predict safe life of welded structures • Energy resources exploration and ecological land control • Improved operation of SC strategic facilities to meet programmatic needs
Energy Efficiency and Renewable Energy	• Diffusion of manufacturing technology for renewable energy equipment • Diffusion of intelligent processes for resource efficiency/reduction of waste
Fossil Energy	• Technology diffusion, e.g., technologies for safety and productivity in extreme environments
Environment, Safety, and Health	• Worker health and safety

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